

# Dr Caroline L. Wormell

Mathematical Sciences Institute  
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**RESEARCH EMPLOYMENT** Postdoctoral Fellow  
Mathematical Sciences Institute, Australian National University, Jan 2023–Dec 2023

Postdoctoral Researcher  
Laboratoire de Probabilités, Statistique et Modélisation, Sorbonne Université and  
CNRS, Paris, Jan 2021–Dec 2022  
Supervisor: Viviane Baladi

**EDUCATION** Doctor of Philosophy  
University of Sydney, Jan 2016–Oct 2020  
Topic: Statistical properties of chaotic systems: from 1D maps to high dimensions  
  
Bachelor of Science (Advanced) (Honours Class I, University Medal)/Bachelor of Arts  
University of Sydney, 2011–15  
Project and coursework in Applied Mathematics  
Topic of project: Linear response theory for systems with non-differentiable response  
Majors in Mathematics and Linguistics

- PUBLICATIONS**
1. \*Vytnova, P. and **Wormell, C.L.**, “Accurate computation of the dimension of Apollonian gasket”. *In preparation*.
  2. †Faranda, D., Messori, G., *13 others* and **Wormell, C.L.**, “A statistical physics and dynamical systems perspective on geophysical extreme events”. Submitted to *Physical Review E* (2023)
  3. **Wormell, C.L.**, “Orthogonal polynomial approximation and Extended Dynamic Mode Decomposition in chaos.” Submitted to *SIAM Journal of Numerical Analysis* (2023): [arXiv:2305.08074](https://arxiv.org/abs/2305.08074)
  4. **Wormell, C.L.**, Conditional mixing in deterministic chaos. *Ergodic Theory and Dynamical Systems* 1–31 (2023). [doi:10.1017/etds.2023.55](https://doi.org/10.1017/etds.2023.55)
  5. **Wormell, C.L.**, “On convergence of linear response formulae in some piecewise hyperbolic maps.” Submitted to *Nonlinearity* (2022): [arXiv:2206.09292](https://arxiv.org/abs/2206.09292).
  6. **Wormell, C.L.**, Non-hyperbolicity in macroscopic dynamics of globally coupled chaotic systems. *Proceedings of the Royal Society A* 478 (2022): 20210808.
  7. **Wormell, C.L.**, “Efficient calculation of statistical properties of intermittent dynamics.” *Preprint arXiv:2106.01498* (2021).
  8. **Wormell, C.L.** and Reich, S., Spectral convergence of diffusion maps: improved error bounds and an alternative normalisation. *SIAM Journal of Numerical Analysis* 59(3) (2021): 1687–1734.
  9. **Wormell, C.L.** and Gottwald G.A., Linear response for macroscopic observables in high-dimensional systems. *Chaos* 29(11) (2019): 113127. Editors’ Pick.
  10. **Wormell, C.L.**, Spectral Galerkin methods for transfer operators in uniformly expanding dynamics. *Numerische Mathematik* 142 (2019): 421–463.
  11. **Wormell, C.L.** and Gottwald, G.A., On the validity of linear response theory in high-dimensional deterministic dynamical systems. *Journal of Statistical Physics* 172(6) (2018): 1479–1498.
  12. \*Gottwald G.A., **Wormell, C.L.** and Wouters J., On spurious detection of linear response and misuse of the fluctuation-dissipation theorem in finite time series *Physica D: Nonlinear Phenomena* 331 (2016): 89–101.

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\*Alphabetical author listing.

†Partially alphabetical author listing.

## TRAVEL FUNDING AND GRANTS

- ANU Early Career Travel Award (A\$3000, 2023)
- ICIAM Financial Support Program 1 (¥50,000, 2023)
- Australian Mathematical Society Cheryl Praeger Travel Award (A\$3000, 2023)
- Australian Mathematical Society Lift-Off Fellowship (A\$4000, 2020)
- SFB 1294 Visiting Research Fellowship (€2047, 2020)
- Postgraduate Research Support Scheme travel grant (A\$3000/year, 2016, 2018–19)
- SFB 1294 Visiting Research Fellowship (€5460, 2018)
- K.E. Bullen Scholarship (A\$3500, 2017)

## CONFERENCE AND COLLOQUIUM PRESENTA- TIONS

- *Polynomial discretisations of transfer and Koopman operators in chaotic dynamics*. Minisymposium presentation at International Congress of Industrial and Applied Mathematics, Tokyo, Aug 2023
- *Conditional mixing and some applications*. Invited presentation at Dynamics, Bifurcations and Numerics, University of Surrey, Jul 2023
- *Chebyshev methods for (hyperbolic and) parabolic IFS*. Presentation at Multifractal analysis and self-similarity, CIRM Luminy, Jun 2023
- *Convergence of Koopman operator approximations*. Seminar for Imperial College Dynamical Systems Group, London, Jun 2023
- *Conditional decay of correlations and applications*. Seminar for Queen Mary University of London Complex Systems group, Jun 2023
- *Structural and statistical stability of globally-coupled dynamics*. Minisymposium presentation at SIAM DS 23, May 2023
- *Linear response theory and conditional mixing in chaotic systems*. Seminar for ANU PDEs and Analysis group, Mar 2023
- *Conditional mixing and applications*. Presentation at Thermodynamic Formalism in Random Dynamics, MATRIX, Creswick, Vic, Jan 2023
- Minicourse on *Numerical methods in (non-hyperbolic) chaos* (5½ hours) for Statistical and Computational Aspects of Dynamics workshop, Pisa, Dec 2022
- *Decay of correlations for conditional measures and some applications*. Presentation at AustMS, University of New South Wales, Sydney, Dec 2022
- *Regularity of foliations of partially hyperbolic systems*. Seminar for Groupe de travail dynamiques sauvages, IMJ-PRG, Paris, Oct 2022
- *Conditional decay of correlations and applications*. Seminar for mathematical physics group, Aalto University, Helsinki, Oct 2022
- *Long-term forecasting using partial perfect observations and linear response*. Presentation at Geophysical fluid dynamics: from mathematical theory to operational prediction, Reading University, UK, Sep 2022
- *Conditional decay of correlations and applications*. Invited presentation at Fractals and Related Fields #4, Porquerolles, France, Sep 2022
- *The chaotic hypothesis and linear response*. Invited presentation at Elliptic Islands and Hyperbolic Waves, Rio de Janeiro, Sep 2022
- *Estimating local dimension and persistence for flows*. Presentation at UNDERPIN Summer School, Centro Ettore Majorana, Erice, Sicily, Jul 2022
- *Prediction from perfect partial observations and linear response*. Invited presentation with funding at Modern Mathematics for Complex Systems, London, Jun 2022
- *Conditional decay of correlations and linear response*. Presentation at Geometry of Deterministic and Random Fractals, Budapest, Jun 2022
- *Diffusion maps and Sinkhorn balancing*. Seminar at Ergodic Theory and Dynamical Systems colloquium, Warwick University, Jun 2022
- *Fast and accurate computation of statistical properties of expanding maps*. Séminaire de théorie ergodique du LPSM, Paris, Mar 2022
- *Linear response in higher dimensions and mixing of Cantor sets*. Presentation at AustMS 2021, online, Dec 2021
- *Applications of Chebyshev transfer operator methods*. Invited presentation with funding at Rencontre ANR Aléatoire, Dynamique et Spectre, Nantes, Nov 2021
- *Abel functions and intermittent maps*. Presentation for Mark Pollicott research group, Warwick, Nov 2021

- *Linear response for piecewise hyperbolic maps and mixing of SRB measure cross-sections.* Seminar at Ergodic Theory and Dynamical Systems colloquium, Warwick University, Nov 2021
- *Linear response in high-dimensional globally coupled systems.* Online seminar for WG Climate & Statistical Mechanics, Université d'Orsay, Oct 2021
- *Non-hyperbolicity in large-scale dynamics of high-dimensional chaotic systems.* Online seminar for Queen Mary University of London Complex Systems group, Oct 2021
- *Convergence of linear response formula for some piecewise hyperbolic maps.* Three seminars for "Smooth dynamics via Operators, with Singularities" group, LPSM, Oct 2021
- *Operator convergence of diffusion maps and the bistochastic normalisation.* Talk at On Future Synergies for Stochastic and Learning Algorithms, CIRM Luminy, Sep 2021
- *Macroscopic dynamics of globally coupled systems.* Invited talk at Second Workshop on Wild Dynamics, São Miguel, Azores, Portugal, Sep 2021
- *Emergence and breakdown of linear response in globally coupled systems.* Talk at International Conference on Mathematical Physics, Geneva, Aug 2021
- *Linear response for the Lozi map and mixing of SRB measure cross-sections.* Invited talk at École d'été finistérienne en systèmes dynamiques, Brest, Jun 2021
- *Operator convergence of diffusion maps and the bistochastic normalisation.* Online minisymposium presentation at SIAM Conference on Applications of Dynamical Systems, May 2021
- *Linear response in high-dimensional globally coupled chaotic dynamics.* Online seminar for Networks and Dynamical Systems series, Courant Institute, New York University, Apr 2021
- *Rigorously validated estimation of statistical properties of expanding maps.* Online talk at AMS Spring Southeastern Sectional Meeting, Mar 2021
- *Linear response theory for diffeomorphisms with tangencies of stable and unstable manifolds.* Two seminars for "Smooth dynamics via Operators, with Singularities" group, LPSM, Feb–Mar 2021
- *Linear response in high-dimensional globally coupled systems.* Online invited talk at Linear Response: Rigorous Results and Applications, Bernoulli Institute, CPFL, Jan 2021
- *Rigorously validated estimation of statistical properties of expanding maps.* Online seminar for CRM-CAMP, Aug 2020
- *Spectral convergence of diffusion maps.* Online seminar for Sydney Dynamics Group, Jun 2020
- *Spectral Galerkin transfer operator methods in uniformly-expanding dynamics.* Online seminar for Georgia Tech CDSNS Colloquium, Jun 2020
- *Linear response in high-dimensional chaotic systems.* Invited presentation with funding. Workshop on multiscale methods for deterministic and stochastic dynamics, University of Geneva, Jan 2020
- *Linear response for macroscopic observables in high-dimensional systems.* Invited presentation with funding. Response theory and its applications in geophysical fluid dynamics, Institut Henri Poincaré, Oct 2019
- *Linear response for macroscopic observables in high-dimensional systems.* Sydney Dynamics Group, Sydney, Sep 2019
- *Spectral Galerkin transfer operator methods in uniformly-expanding dynamics.* Invited presentation. Thermodynamic Formalism: Ergodic Theory and Validated Numerics, CIRM Marseille Luminy, France, Jul 2019
- *Mesh-free solving of nonlinear PDEs via forward-backward SDEs.* ANZIAM, Nelson, New Zealand, Feb 2019
- *Validity of linear response theory in high-dimensional deterministic dynamical systems.* Seminar for SFB 1294, University of Potsdam, Dec 2018
- *Chebyshev Galerkin methods for transfer operators in uniformly-expanding dynamics.* Seminar at Centro di Giorgi Dynamics group, Pisa, Nov 2018
- *Chaotic systems and ergodic theory.* Talk at Center for Atmospheric and Oceanic Sciences graduate student lunch, New York University, Nov 2018

- *Introduction to Julia*. Talk at Center for Atmospheric and Oceanic Sciences graduate student lunch, New York University, Oct 2018
- *Rigorous and accurate numerical computation for intermittent maps*. Dynamics Days Europe, Loughborough, UK, Sep 2018
- *Tight coupling bounds on decay of correlations in Markovian uniformly expanding dynamics*. Sydney Dynamics Group, Sydney, Jul 2018
- *Linear response in weakly-coupled systems*. ANZIAM, Hobart, Feb 2018
- *Spectral Galerkin methods for transfer operators*. AustMS, Sydney, Dec 2017
- *On spurious detection of linear response in chaotic systems with finite time series*. Emerging Aspirations in Complex Systems Mini-Workshop, Sydney, Oct 2017
- *Fast numerical approximation of intermittent maps*. ANZIAM, Adelaide, Feb 2017
- *Constituent structure in Palauan*. Australian Linguistics Society Conference, Melbourne, Dec 2016

## TEACHING

- Postdoctoral Fellow, ANU Mathematical Sciences Institute (2023)  
Duties: lecturing and administration of half a first-year service course (110 students).  
Courses taught: Mathematics and Applications 2, linear algebra component.
- Postgraduate Teaching Fellow, University of Sydney School of Mathematics and Statistics (2016–2020)  
Duties: giving tutorials and examples-focused lectures, marking assignments and final exams, responding to student emails, developing online quizzes.  
Courses taught: differential, integral and vector calculus, linear algebra, introduction to statistics, analysis and intermediate and senior level PDEs.
- Casual tutor, University of Sydney School of Mathematics and Statistics (2015, 2020)  
Duties: giving tutorials (in person and online) and marking assessments.  
Courses taught: differential calculus and statistics.

## AWARDS AND SCHOLARSHIPS

- Faculty of Science Postgraduate Research Prize for Outstanding Academic Achievement (2019)
- Best poster award at “Advances in Ergodic Theory, Hyperbolic Dynamics, and Statistical Laws”, Canberra (2016)
- The University Medal (2015)
- The Joye Prize for most outstanding Honours student in Mathematics and Statistics (2015)
- K.E. Bullen Memorial Prize for proficiency in Applied Mathematics Honours (2015)
- M.J. and M. Ashby Prize for best Honours essay in Mathematics (2015)
- Arthur Capell Prize for an Essay on Australian and Pacific Linguistics (2014)

## EXPOSITORY TALKS

- *Regularity of foliations of partially hyperbolic systems*. Seminar for Groupe de travail dynamiques sauvages, IMJ-PRG, Paris, Oct 2022
- *Abel functions and intermittent maps*. Presentation for Mark Pollicott research group, Warwick, Nov 2021
- *Convergence of linear response formula for some piecewise hyperbolic maps*. Three seminars for “Smooth dynamics via Operators, with Singularities” group, LPSM, Oct 2021
- *Linear response theory for diffeomorphisms with tangencies of stable and unstable manifolds*. Seminar for “Smooth dynamics via Operators, with Singularities” group, LPSM, Mar 2021
- *Chaotic systems and ergodic theory*. Center for Atmospheric and Oceanic Sciences graduate student lunch, New York University, Nov 2018
- *Introduction to Julia*. Center for Atmospheric and Oceanic Sciences graduate student lunch, New York University, Oct 2018
- *A user’s guide to chaotic systems*. USyd Mathematics Postgraduate Seminar Series, Oct 2017

**SERVICE AND  
PUBLIC  
ENGAGEMENT**

- Active in the Julia Sydney Meetup group, consisting largely of industry users of programming language Julia, including giving presentation *Numerical computing with functions in Julia* (2017)
- Developed and presented part of a science communication workshop for postgraduate students (2018)
- Reviewer for journals including *Journal de Mathématiques Pures et Appliquées*, *Numerische Mathematik*, *SIAM Applications of Dynamical Systems* and *Applied and Computational Harmonic Analysis*

**SOFTWARE  
PACKAGES**

- Poltergeist.jl (<https://github.com/wormell/Poltergeist.jl>)  
Julia package for accurate calculation of statistical properties of one-dimensional maps using adaptive spectral methods.

**SKILLS**

- Natural languages: English (native speaker); French (B1)
- Computer languages: Julia; MATLAB; Mathematica; Python